UNIVERSITY OF ALBERTA LIBRARY
0 1620 0399 0601

1995-96 School Year

Biology 30 Information Bulletin

Diploma Examinations Program

LB
3054
C2
D52563
1995/1996
c.2

EDUC

Students
First!
Student Evaluation

Alberta
EDUCATION

QUAECUMQUE VERA
EX LIBRIS
UNIVERSITATIS
ALBERTÆNSIS

This document was written primarily for:

Students	✓
Teachers	✓ Biology 30 teachers
Administrators	✓
Parents	
General Audience	
Others	

Distribution: Superintendents of Schools • School Principals and Teachers • The Alberta Teachers' Association • Alberta Education • General Public upon Request

Copyright 1995, the Crown in Right of Alberta, as represented by the Minister of Education, Alberta Education, Student Evaluation Branch, 11160 Jasper Avenue, Edmonton, Alberta T5K 0L2. All rights reserved. Additional copies may be obtained from the Student Evaluation Branch, 403-427-0010.

Permission is granted to Alberta educators to reproduce, for educational purposes and on a non-profit basis, this bulletin or any of its parts.

Contents

Page 1 *Purpose of the Bulletin*

Page 2 *Important Dates in 1996*

Administration of the Biology 30 Diploma Examination
Scoring of the Examination

Page 3 *Notes of Interest*

Information About Markers
Item Writing and Field Testing
Reports
Inservices and Presentations
Student Use of Scientific Calculators
Data Resources for Students
Student Requests for Rescores
Student Requests for Rewriting

Page 6 *Biology 30 Information*

Objectives of the Course
Standards
Examination Specifications
Examination Design
Assessment of STS Connections
Assessment of Communication Skills
NEW **One-Marker Scoring System**
NEW **Sample Question and Scoring Guide**
NEW **Two-Marker Scoring System**
NEW **Sample Question and Scoring of Sample Answers**

Page 23 *Appendices*

Appendix A **Policy: Use of Scientific Calculators on Alberta Education Diploma Examinations**

Appendix B **Examination Rules, Grade 12 Diploma Examinations**

Appendix C **Guidelines for Significant Digits, Manipulation of Data, and Rounding in the Mathematics and Sciences Diploma Examinations**

Appendix D **Explanation of Cognitive Levels Directing Words**

Appendix E **Preparing to Write a Science Diploma Examination—What every student should do before the examinations!**

Appendix F **Suggestions for Students When Writing Science Diploma Examinations—What every student should know when writing examinations!**

Appendix G **Science Process Words**
Chromosome Number Descriptions

Appendix H **Instructions for Completing the Numerical-Response Questions**

UNIVERSITY LIBRARY
UNIVERSITY OF ALBERTA

Purpose of the Bulletin

The purpose of this bulletin is to provide students and teachers of Biology 30 with information about the diploma examinations scheduled for 1996.

We encourage teachers to share the contents of this bulletin with students and to review the scoring criteria with them.

If you have requests, questions, or comments about the contents of this bulletin, please contact:

Yvonne Johnson
Acting Assistant Director
Mathematics/Sciences Diploma Examinations

Karen Slevinsky
Examination Manager, Biology 30

Mailing address, telephone, and fax number:

Student Evaluation Branch
Alberta Education
Devonian Building, West Tower
11160 Jasper Avenue
Edmonton, Alberta T5K 0L2

Telephone: 403-427-0010
Fax: 403-422-4200

Important Dates in 1996

Administration of the Biology 30 Diploma Examination

1996 Administrations	*Time**
Tuesday, January 30	9:00–11:30 A.M.
Thursday June 27	9:00–11:30 A.M.
Thursday, August. 15	9:00–11:30 A.M.

* The diploma examination is designed for a writing time of 2.5 h. Students may have an additional 0.5 h to complete the examination.

Scoring of the Examination

1996 Administrations	*Scoring Dates***
January	February 7 (Head Markers) February 8 to 10
June	July 8 (Head Markers) July 9 to 12
August	August 16

* * Dates are tentative and will be confirmed by telephone with markers.

Notes of Interest

Information About Markers

The written-response questions of the Biology 30 Diploma Examinations are marked by Biology 30 teachers selected from those who have been recommended as markers to the Student Evaluation Branch by their superintendents. To qualify for recommendation, a teacher must have taught the complete Biology 30 course twice, be teaching the course in the current school year, and have an Alberta or Northwest Territories Permanent Professional Teaching Certificate.

Often, more teachers are recommended as markers by superintendents than are required by the Student Evaluation Branch for any one marking session. The following criteria are considered when markers are selected for a particular marking session:

- experience as a marker (experienced markers and first-time markers are included)
- regional representation (by zone, jurisdiction, and school)
- student population (proportional representation)

Teachers who can mark examinations written in French are particularly needed.

Teachers who wish to be recommended as markers for the January 1996 examination should contact their superintendents by September 22, 1995. Teachers who wish to be recommended as markers for the June and August 1996 examinations should contact their superintendents by **February 23, 1996**.

Item Writing and Field Testing

As the need arises for teachers to participate in field testing and item writing, letters are sent to superintendents requesting their nominations. **Teachers who are interested in these activities should let their superintendents know by September 22, 1995.**

Reports

After each January and June administration of the Biology 30 diploma examination, copies of the *Examiners' Report* for that particular administration are sent to teachers in all senior high schools in Alberta. The report contains provincial results along with comments about student performance on the examination. Examiners' reports are designed for teacher use. If these reports can be made more useful in any way, contact Student Evaluation Branch.

School and Jurisdiction Statistical Reports are sent to each superintendent and senior high school principal after each January and June administration of the Biology 30 diploma examination. These reports provide detailed information on how well the students in their school district and school, respectively, did on the Biology 30 diploma examination. Teachers may use these data to reflect on the areas of the program where their students did well and those areas where student performance was poor.

Each year, copies of a document entitled *Annual Report, Diploma Examination Program,* are sent to each superintendent and senior high school principal in Alberta. The report contains information about the results achieved by students who wrote diploma examinations in the school year. It also contains special studies on topics of interest. The first annual report (1989–90 school year) contains a study comparing achievement in various diploma courses. The second report (1990–91 school year) contains a study comparing the achievement of students who repeat diploma examination courses and rewrite diploma examinations with their achievement the first time and with the achievement of students who write only once. The third report (1991–92 school year) contains a study of participation rates in diploma examination courses. The fourth report (1992–93 school year) contains a study of English 30 students' application of conventions of language. The fifth report (1993–94 school year) presents a comparison of provincial participation rates in diploma examination subjects for the school years 1991–92, 1992–93, and 1993–94. Each of these special studies will be of interest to teachers who are involved in interpreting diploma examinations results of their students.

Inservices and Presentations

On a limited basis and subject to budget constraints, Student Evaluation Branch staff is available to provide inservices or presentations related to diploma examinations or the interpretation of diploma examination results.

Student Use of Scientific Calculators

Examinations are constructed to ensure that the use of particular scientific calculators neither advantages nor disadvantages individual students. Students are expected to provide their own scientific calculators.

Refer to Appendix A for the policy statement on the use of scientific calculators on diploma examinations. Students should be made aware of this policy as early as possible in the school term to ensure they are able to use the scientific calculator of their choice when writing examinations.

Students should also be made aware of the Examination Rules, Grade 12 Diploma Examinations (see Appendix B). Students should know that notes stored in electronic devices may not be brought into the examination room.

Data Resources for Students

The Biology 30 diploma examinations contain tear-out data pages. Students should remove the tear-out data pages from the exams at the beginning of the writing session. These pages do not have to be returned with the exam booklets and answer sheets. The data presented are generic for all of the Biology 30 diploma exams provided during a school year; therefore, only some of the data are useful for any particular exam.

Student Requests for Rescores

Students may request a rescoring of their diploma examinations. Before applying for a rescoring, students should check their Diploma Examination Results Statement to find out the distribution of marks. The mark on the machine-scored questions is not likely to change as a result of a rescore, but the written-response mark could change slightly. Students should remember that the rescored mark will be the final mark whether it *increases* or *decreases*.

Students who decide to have an examinaton rescored must ensure that their application is received before the deadline specified on the results statement. The fee for rescoring each examination is $26.75, which includes GST. If a diploma examination mark is increased by 5% or more as a result of rescoring, the fee is refunded.

Student Requests for Rewriting

Students may rewrite a diploma examination in any regularly scheduled administration. Students must apply to the Student Evaluation Branch by November 15, 1995, and April 15, 1996, to be eligible to write the January and June diploma examinations. The tentative fee for rewriting each examination is $26.75, which includes GST. (For more details, see the *General Information Bulletin*.)

Biology 30 Information

Objectives of the Course

Biology 30 is intended for students who want to better understand the biology principles behind the natural events they experience and the technology they use in their daily lives. Biology 30 is an experimental discipline requiring creativity and imagination. The course is designed for students who are preparing for academic post-secondary studies.

Students of Biology 30 have developed their aptitude for observing, collecting facts, forming generalizations, hypothesizing, and making inferences from observations. They have shown growth in their understanding of biological concepts by their increased ability to apply these concepts to relevant situations. They have learned to communicate in the specialized language of biology.

This growth and development in students has taken place as a result of general education and cognitive maturation. It has been enhanced by science courses, in particular by the successful completion of Science 10 and Biology 20. These courses develop knowledge and skills that are prerequisite to success in Biology 30.

Standards

Students who attain an *acceptable* standard of performance in Biology 30 receive a final mark of 50% or higher. These students can demonstrate a basic understanding of the nature of scientific inquiry by designing, observing, and interpreting simple laboratory and field investigations. They can readily interpret physiological, genetic, and ecological data that are presented in simple diagrams, tables, and graphs. They can translate word descriptions of biological processes into symbolic representations that facilitate solving simple quantitative genetic and ecological problems. These students can demonstrate an acceptable level of understanding of *equilibrium* by describing how the human nervous and endocrine *systems* regulate other body processes such as reproduction. They can show how environmental and genetic factors regulate *change* in the development of organisms. They can describe how cellular and molecular processes cause *diversity* in organisms. They can illustrate how populations interact with each other, thereby forming communities that over time are in *equilibrium* or a state of *change*. These students recognize and understand key biological and technological terms and therefore can interpret short reports of current biological issues. They can identify the scientific, technological, and societal components of biological problems and explain how these components interrelate in solutions. These students can compose clear and logical descriptive or explanatory statements about major biological issues.

Students who attain a standard of *excellence* in Biology 30 receive a final mark of 80% or higher. In addition to meeting the expectations for an acceptable standard of performance, these students demonstrate their aptitude and interest in biology and feel confident about their abilities. They can readily interpret interrelated sets of data such as complex graphs and tables. They can analyze and evaluate experimental designs. These students can provide explanations of concepts that are specific but also comprehensive. They can simultaneously apply two or more biological concepts that cross major themes. They can demonstrate a thorough understanding of quantitative relationships and solve multistep numerical problems. When presenting scientific data, they select the most appropriate form. They can analyze complex open-ended issues that are of a new or unique nature. The contexts of these issues would most likely include current investigations of homeostatic mechanisms or current genetic research. These students are aware of a variety of viewpoints relating to the environmental and ethical issues in the field of science and technology. Exceptional students can communicate clearly and concisely, using appropriate scientific vocabulary, and can write compositions.

Examination Specifications

Each Biology 30 diploma examination is designed to reflect the *Biology 30 course* general learner expectations outlined in the *Biology 20–30 Program of Studies, Interim 1994, for Senior High Schools*. The general learner expectations are expressed in more detail by the specific learner expectations, which are organized into four units. Some questions on each diploma exam will assess achievement of specific learner expectations. Some questions will be based on the integration of several specific learner expectations.

All examination questions are organized into sets that relate to broad contexts. Therefore, a set of questions may assess students' ability to integrate several general learner expectations (GLEs). All questions will measure achievement of scientific knowledge; some will also measure achievement of skills and /or STS connections.

Examination Specifications (continued)

The 1995 Biology 30 diploma examinations are constructed to place the following approximate emphases on the Biology 30 Course General Learner Expectations.

Knowledge The student can show that:	***Emphasis***
• humans use nervous and endocrine systems to maintain internal equilibrium among their systems while simultaneously interacting and maintaining equilibrium with the external environment	20–25%
• humans and other organisms have chemically regulated reproductive systems, which ensure survival of the species, and can describe how sexually transmitted diseases interfere with human reproductive function	10–15%
• cell differentiation and organism development are regulated by genetic and environmental factors and that natural processes can be changed by using reproductive technologies	5–10%
• cell division in vascular plants and animals promotes growth, genetic continuity, and diversity of organisms; and that genetic traits are inherited and expressed in predictable ways if chromosome segregation, assortment, and crossing over are taken into account	25–30%
• genetic information stored in DNA molecules directs the functions of organisms and that biotechnology can be used to influence genetic expression	10–15%
• gene frequencies within populations determine the composition of communities and that these gene frequencies may reach equilibrium or continue to change over time as populations interact	15–20%

Skills — ***Emphasis*** 20–30%

The student can:

- design, interpret, explain, analyze, and evaluate investigations
- organize data into tables, graphs, and diagrams and predict relationships
- interpret, explain, analyze, and evaluate data to infer relationships
- use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts

Connections Among Science, Technology, and Society (STS) — ***Emphasis*** 20–30%

The student can:

- apply cause-and-effect reasoning to formulate relationships in which scientific evidence shapes or refutes a theory, and explain the limitations of science and technology in answering all questions and solving all problems
- describe and evaluate the design and function of technological solutions to practical problems using scientific principles and theories, and relate the ways in which science and technology advance one another
- evaluate from a variety of perspectives how science and technology are influenced and supported by society, and assess the ability of society to interact responsibly with the environment
- apply the skills and knowledge acquired in Biology 30 to everyday life and to related and new concepts in post-secondary studies of biology

Examination Design

The design of the 1996 Biology 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Percent Emphasis*
Multiple Choice	48	60
Numerical Response	8	10
Written Response	2	30

The machine-scored portion of each examination contains both multiple-choice and numerical-response questions, some of which may be linked together.

Multiple-choice questions are of two types: *discrete* and *context-dependent*. A discrete question stands on its own without any additional directions or information. It may take the form of a question or an incomplete statement. A context-dependent question provides information separate from the question stem. Most of the multiple-choice questions are *context-dependent*.

A particular context may be used for more than one multiple-choice question, one or more numerical-response questions, as well as for one written-response question.

Answers for multiple-choice questions are recorded in the first section of the machine-scored answer sheet, and answers for numerical-response questions are recorded in the second section on the same side of the same machine-scored answer sheet. Answers to the written-response questions are written right in the exam booklet.

Numerical-response questions are of three types: calculation of numerical values, selection of numbered events or structures from a list, and determination of a sequence of events. Specific instructions for recording answers for each type of numerical-response question, as well as examples of each type, are provided in *Appendix H*. It should be noted that the correct answer for any one question will not necessarily require use of all four columns in the grid provided on the answer sheet.

The written-response portion of each Biology 30 diploma examination contains two contextual questions: a closed-response question and an open-response question. Each question has a value of 15 percent.

The closed-response question presents a synopsis of a research project. Pertinent data are provided in the form of graphs and/or tables. The several parts of this question require students to demonstrate a variety of science process skills.

The open-response question presents a problem that requires students to make connections between biological concepts, technology, and/or social issues. Furthermore, an acceptable response will demonstrate good communication skills.

Assessment of STS Connections

Students' understanding of the concepts of science are measured by every question on the examinations. In addition, some questions measure the students' development of the skills and thinking processes associated with scientific inquiry. Some questions will measure students' understanding of the interrelationships between science and technology and among science, technology, and society.

Students are advised that no one viewpoint will be considered more worthy of serious consideration than another in response to an open-ended question. Holistic scoring of "issues" and "decision-making" questions will be guided, however, by the following principles:

- The problem-solving process should be organized, rigorous, and intellectually sound; that is, the process should not be limited to emotional assertions and uninformed opinions
- Analyses of moral dilemmas should focus on the **goals**, **rights**, and **duties** of the participating groups
- All credible arguments should meet two standards:
  - —valid conclusions must follow from the reasons by accepted rules of logic
  - —all reasons must count as good reasons for everyone

Note: If a person's particular religious belief or conviction can be shown to be important to everyone, then the belief can be counted as an argument. If the religious belief is of parochial significance only, then it cannot be counted as an argument: but it is still important to the person who proposed it. This approach should also apply to moral beliefs, including those of non-religious origin.

References:

"Mapping and Sequencing the Human Genome: Science, Ethics, and Public Policy." BSCS and the American Medical Association, Colorado Springs: BSCS (1992)

McInernery, J. D. "Ethical values in biology education." *Ethics and Social Responsibility in Science Education.* Toronto: Pergamon Press (1986), pp. 175–181.

Morris, Linda J. "Bioethical Dilemmas, Decision-making and the Human Genome Project." *The Science Teacher*, February, 1994, pp. 39–41.

Assessment of Communication Skills

Communication skills are assessed most directly in the teacher-scored questions. For the open-response questions, the descriptions used in the holistic scoring guides may include criteria for assessing communication skills along with criteria for the other components. The term *communication skills* includes those processes by which information is exchanged through appropriate conventions. These conventions include:

- words, sentences, paragraphs
- graphs, diagrams
- mathematical formulas, mathematical and chemical equations
- significant digits, units of measurement

Conventions that are considered appropriate for a particular response are subject- and question-specific.

One-Marker Scoring System

NEW

Each Biology 30 Diploma Examination has two written-response questions, one of which is a closed-response question. The students' answers to this question are scored by one teacher using an analytic scoring guide. Each guide lists criteria required for each mark along with a sample response that meets all the criteria for a score of 12. The following example is taken from the June 1995 Biology 30 Diploma Examination.

Sample Question and Scoring Guide

Written-Response Question 1, June 1995

NEW

Use the following information to answer the next question.

Genetically Engineered Plants on Trial

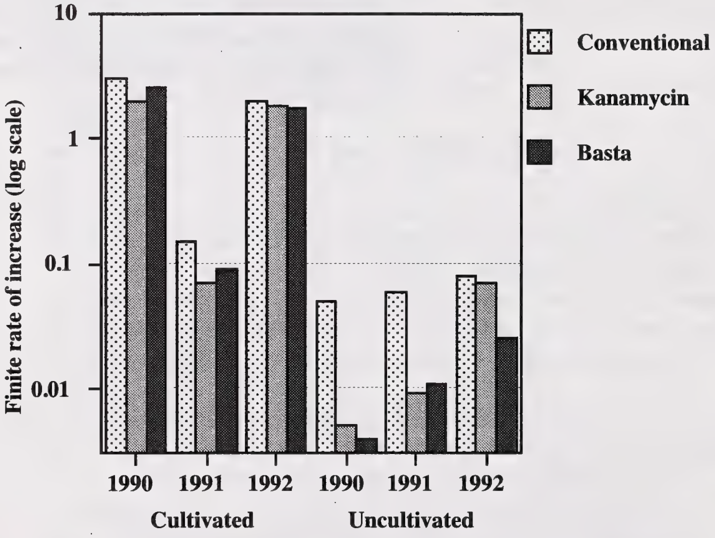
M. J. Crawley and his colleagues in England performed an ecological study that addressed the debate about the use of genetically engineered plants in agriculture. The debate centres on the possible invasion of such plants into natural habitats where they are not wanted.

Crawley's study used both genetically engineered and conventional (unmodified) canola plants. The conventional variety of canola is commonly grown in Alberta as a crop. Two genetically engineered varieties included one tolerant to the herbicide glufosinate (Basta variety) and one that expressed a tolerance to the antibiotic kanamycin (Kanamycin variety).

The three varieties of canola were grown from 1990 to 1992 in cultivated and uncultivated plots. From the data, a comparison of the ecological performance of the three different genetic lines was made.

The growth of the three varieties of canola was also tested in four different climatic conditions (wet versus dry and sunny versus shady.)

Finite Rate of Increase for Three Varieties of Canola in Cultivated and Uncultivated Plots



The finite rate of increase is a measure of the ability of a plant to survive and increase in number in an environment. If the finite rate of increase is greater than 1, the plant will increase in abundance. If it is less than 1, the plant will decline to extinction. The cultivated plots were cleared of all vegetation before planting. Uncultivated plots had intact native vegetation.

(3 marks) 1. **a.** State three conclusions that can be made based on the data.

Award 1 mark each for any three of the following.

- In the cultivated plots, all three varieties will increase in abundance (finite rate of increase is > 1), OR in noncultivated plots, all three varieties will decrease in abundance (finite rate of increase < 1).
- All three varieties performed better in the cultivated plots than in the uncultivated plots, OR there was competition from the natural vegetation in the uncultivated plots.
- The conventional canola performed better every year in both types of plots.
- The genetically engineered plants performed as well as the conventional variety in cultivated plots, OR the genetically engineered plants performed least well in the uncultivated plots.
- Growing conditions varied throughout the study (over three years). For example, plants did poorly in 1991 in the cultivated plots, OR plants did very well in 1990 in the cultivated plots.

(1 mark) **b.** Provide one reason for the differences in the finite rates of increase of canola in cultivated plots compared to canola in uncultivated plots.

Award 1 mark for any of the following.

Cultivated plots	**Uncultivated plots**
• less competition (or an example/description of competition)	• more competition
• more O_2 available	• less O_2 available
• more H_2O available	• less H_2O available
• increased nutrient absorption (not referring to application of fertilizer)	• less nutrients available
• more space	• less space (crowding)
• loosened soil allows enhanced root growth	
• mixing of existing nutrients between soil layers	

Note:

- must specify the plot to which condition refers
- "loosening of the soil" is not a reason per se
- the physiological responses of the plants are not reasons (e.g., cannot receive a mark for saying that the germination rate was greater in the cultivated plot).

(2 marks)

c. The significance of Crawley's study is not so much the outcome of the study but that the thoroughness of the study sets a standard for future experiments of this nature. Identify two ways in which this study illustrates good scientific research skills.

Award 1 mark each for any two of the following.

- cultivated plots compared to uncultivated plots
- conventional canola compared to genetically engineered varieties
- study was carried on over three years (long length of time)
- two types of genetically engineered canola were studied
- study was done in a variety of climatic conditions (wet vs. dry, sunny vs. shady)

(2 marks)

d. Describe one advantage and one disadvantage of the development of herbicide-resistant crop plants like the Basta variety described in this study. (Herbicides are substances that kill plants.)

1 mark - Advantage:
- Competitive weeds could be removed with herbicides without harm to the crop.

1 mark - Disadvantage:
- Herbicide-resistant canola might become a pest (weed) and would be difficult to control.

or
- Commercial use of herbicide-resistant plants might encourage herbicide use.

or
- Biological amplification of the herbicide might occur in the environment.

or
- Natural selection could result in the development of other herbicide-resistant plants (weeds).

or
- Nearby plants/crops might be affected by herbicide drift.

Canola is an annual with a simple life cycle. Seeds germinate in the spring. Flowering and seed ripening occur during the summer. Seed is shed in early fall.

To determine the survival rate of germinating seeds in uncultivated plots, 400 seeds of each of the three varieties of canola were buried below the natural vegetation in flat nylon-mesh beds in each of 12 habitats. Also buried were 400 Charlock seeds, a naturally occurring, "wild" relative of canola.

The table shows the total number seeds that germinated (out of the 400 of each type originally buried) in each of the 12 habitats.

Habitat Number	**Conventional Variety**	**Kanamycin Variety**	**Basta Variety**	**Charlock**
1	37	4	10	218
2	3	2	0	144
3	5	2	0	243
4	0	0	4	180
5	60	1	1	302
6	16	11	0	322
7	0	0	1	239
8	2	0	1	256
9	0	0	1	50
10	28	2	1	263
11	16	6	0	324
12	6	0	2	341

(2 marks)

e. Determine the average survival rate (%) for each of the three varieties of canola seeds and the Charlock seeds originally buried in **habitat 1**.
Show your method.

Award 1 mark for method.
e.g., Conventional canola (37/400) **or** (37/400) × 100% **or** (37/400) × 100%

Award 1 mark for correct survival rates (ignore significant digits).

Conventional canola	9.25% **or** 9.3% **or** 9%
Kanamycin variety	1.00% **or** 1.0% **or** 1%
Basta variety	2.50% **or** 2.5% **or** 3%
Charlock	54.50% **or** 54.5% **or** 55%

(1 mark)

f. What was the purpose of burying the Charlock seeds in this experiment?

Award 1 mark for either of the following:

- The Charlock seeds served as a basis for comparison of the survival rate of the canola to a "wild" plant (control group).
- The Charlock seeds were buried because the other seeds in the study were buried.

(1 mark)

g. Based on the survival data, provide a hypothesis about the invasion of canola used in agriculture into natural habitats in Alberta.

1 mark - If canola were dispersed into natural habitats, then it is unlikely that the canola will survive.
or
Agricultural canola will not survive in natural habitats in Alberta.

Two-Marker Scoring System

NEW

The other written-response question is an open-response question. Students' answers to the open-response question are scored by teachers using a holistic scoring guide. The guide describes the characteristics of students' answers that correspond to one of five values: 0, 1, 2, 3, or 4. Each student's answer is scored independently by two teachers. The two scores are added together for a combined total sub-score out of 8.

If the two scores obtained by the two independent readings represent a difference of 2 or more scale categories on the guide, the scores are classified as *discrepant*. Student responses that have *discrepant* scores are read by a third reader. The third reader will assign a score that is within the limits established by the discrepant scores of the first two readers. This score will be multiplied by 2 for a total sub-score out of 8.

The sub-score out of 8 is then pro-rated out of 12. A summary of the calculations follows:

Reader 1 Score _____ out of 4
Reader 2 Score _____ out of 4
Sub-score _____ out of 8

$$\frac{\text{Pro-ratedRawScore}}{12} = \frac{\text{Sub-score}}{8} \times 1.5$$

Sample Question and Scoring of Sample Answers

Written-Response Question 2, January 1995

NEW

Use the following information to answer the next question.

In the 19th century, individuals who were not among the "normal" population were often thought to be failures or defectives. Early in the 20th century, the interaction of genetics, law, and society resulted in policies of enforced sterilization, restrictive immigration, and institutionalization of those thought to be genetic defectives. As this century closes, society will have difficult choices to make about the legality, morality, and economics of applying genetic knowledge and technology. The difficulty of this situation is summarized in the words of a famous geneticist, Theodosius Dobzhansky (b.1900 – d.1975):

> "If we enable the weak and the deformed to live and produce more of their kind, we face the prospect of a genetic twilight (decline). But if we let them die or suffer when we can help them, we face the certainty of a moral twilight."

Consider the following proposal:

People with genetic abnormalities should not be discouraged from having families. Doctors should attempt to treat every genetically related health problem and to keep people alive at all cost.

If this proposal were initiated, there would be many effects on our society. Describe three ethical medical technologies that would reduce the financial costs created by initiating this proposal. Evaluate the proposal from both a genetic and a moral point of view.

Your response should include the following information:

- A description of three medical technologies that are ethical and that would likely reduce some of the financial costs created by initiating the proposal
- A balanced argument for and against the proposal from the scientific perspective of a geneticist
- A balanced argument for and against the proposal from the perspective of a policy maker (e.g., a politician or a religious leader)

Scoring Criteria for Written-response Question 2, January 1995

Score	Scoring Description		
	Technology	Evaluation of the Proposal	Presentation
4 **Standard of Excellence** The response addresses all of the major points of the question.	• Three appropriate technologies are described.	• An unbiased pro *and* con evaluation is presented from the perspective of a geneticist *and* a policy maker.	• Explanations of concepts are clear, concise, and logical. • Complete, grammatically correct sentences are used. • Appropriate scientific vocabulary is used effectively. • Consistency of thought is demonstrated. • The response is well organized.
3 The response addresses most of the major points of the question.	• Two appropriate technologies are described.	• A pro *and* con evaluation is presented from the perspective of *either* a geneticist *or* a policy maker *and* • A pro *or* a con is presented from the second perspective.	• Explanations of concepts are clear. • Complete sentences are used. • Some appropriate scientific vocabulary is used. • Consistency of thought is demonstrated. • The response is organized.
2 **Acceptable Standard** The response addresses some of the major points of the question.	• One appropriate technology is described and a second is identified.	• A pro *and* con evaluation is presented from the perspective of *either* a geneticist *or* a policy maker.	• Most explanations of concepts are clear. • Some appropriate scientific vocabulary is used. • Some organizational skills are evident.
1 The response addresses few of the major points of the question.	• 1–3 appropriate technology(ies) is/are identified.	• A pro *or* a con is presented from the perspective of *either* a geneticist *or* a policy maker.	• Little appropriate scientific vocabulary is used. • Organizational skills are not evident.
0 The response does not address the major points of the question.	• Technologies are not identified.	• No evaluation of the proposal is given.	

Sample Answers

The sample answers for this question were scored by a group of classroom teachers using the scoring criteria on the previous page. Writing style, spelling and grammatical errors can be thought to be typical of student responses.

Sample Answer—Score 4

Many medical technologies can be used to reduce the financial costs that would be created if this proposal were initiated. One such technology would be an amniocentesis during pregnancy. This consists of taking a sample of the amniotic fluid of the developing baby and testing it for genetic defects. This procedure will allow doctors to detect genetic abnormalities before the child is born so that treatment can be applied as soon as possible to reduce the long term treatment costs.

Another medical technologie that may be used is gene therapy, or more specifically gene splicing. This technologie involves using enzymes to cut out a section of DNA and then replacing it with a different section. This technologie will allow doctors to fix the abnormalities in the gametes of individuals with genetic disorders so that the child will be born normal and therefore no additional threatment costs will be necessary.

A final medical technologie that may be used is invitro fertilization. Doctors can take eggs and sperm from people with no genetic disorders and then transplant the fertilized egg into the individual with the genetic disorder. The child will develop normally and since the child shares no DNA with the mother there will be no risk of genetic defects. This procedure will allow for minimal costs since the child will be born normal.

Geneticists will see many risks and benefits should this proposal be initiated. A possible benefit that a geneticist may see is that this proposal will give them plenty of chance to study and monitor genetic abnormalities. Because these abnormalities may show up more offten, they can more easily be identified and studied. A possible risk that geneticists may encounter would be that the gene pool would become weak with the added genetic deformalities of the people having children.

A policy maker may also see many risks and benefits. A possible benefit their point of vue would be that every body is being treated equaly and every body has equal chance to have children, and reproduce. A risk that they may see is the added burden of additional children with genetic abnormalities on the community and on the family.

Sample Answer—Score 3

Win/Loose

This topic certainly has numerous PROS and CONS to it.

Three medical technologies that may be utilized are ① Genetic alteration, the genes of the unborn are altered early enough so that the fetus may develop without the genetic abnormality. ② INVITRO FERTILIZATION – BOTH THE SPERM & EGG PLACED IN THE PETRIE DISH. AFTER CONCEPTION & DIVISION TAKE PLACE, THE EMBRYO CAN BE RESEARCHED FOR GENETIC IMPERFECTIONS. IF IMPERFECTIONS ARE PRESENT THE PREGNANCY MAY BE TERMINATED. However, this now opens a new topic. IS Termination of a pregnancy Ethical. ③ A Donor Parent may mate with a parent that has a History of genetic imperfections. While mating with the donor who has NO History of genetic imperfections, this may decrease the probability of the fetus inheriting these imperfections. The above technologies would decrease or even prevent financial costs related to initiating the proposal.

I believe if people with genetic abnormalities have families, it will add variation and evolution to the population. However, if a person is kept alive at all costs, regardless of financial cost, is that person going to lead a quality life, or is he/she going to suffer a great deal. Taking a different approach, if this person is kept alive, a medical cure or medical technology may be found which will help numerous amounts of people with the same or different genetic abnormality. Religious leaders may believe life is precious or not worth suffering. A moral view may be considered by Religious leaders. In the hand of a politician, money is a big deal. Politicians may rather have money spent in places where it can be utilized more effectively. In closing, People may believe the sufferers are not worth the worry or money, but what if that person was their, spouse, child, brother or sister. The shoe is on the other foot now isn't it.

Sample Answer—Score 2

A medical technology that could be used is gene splicing. This technology, which involves removing the defected part of the gene (chromosome) and replacing it with a healthy one, could cure many gene abnormalities. Another technology which involves similar precedures is gene insertion. A final technology which could lead to helping people with genetic abnormalities is gene modification. This could eventually lead to less financial costs because people would be cured and therefore not pass the abnormality to their offspring. Also, people would pay a lot of money for the procedure which may even be beneficial for the medical business.

People with genetic abnormalities should not be discouraged to have children. Everyone in the world should have that right. Besides, the person has a possibility to produce healthy children. People with genetic disorders should never be turned away by society. They deserve to be treated equally and fairly. It is a doctor's job to help those who need treatment and they should attempt to treat every genetically related health problem and to keep people alive at all costs.

People with genetic abnormalities produce some cons on our society. They should be discouraged to have children because the children may get their abnormality causing suffering for that child. Also it causes our society to be weaker, with more abnormalities our society can't grow to be a healthy and stronger place. The human race can't be at it's best. FOR Religious Leader: God created these abnormalities for a reason and we should love and help them just like we would help any other of our brothers and sisters. AGAINST Religious Leader: We should help these people but we must also help them make the right decisions. They should be encouraged not to have children so that their children won't have to suffer as they suffer.

Their are many pros and cons of helping those with genetic abnormalities though I think that the human race should do whatever possible to help them. "Treat others as you would like them to treat you". This saying is important because a lot of times we don't think about being in the other person's shoes and how they must be feeling.

Sample Answer—Score 1

In the proposal it stated that "Doctors should attempt to treat every genetically related health problem and to keep people alive at all costs." Knowing today that the cost of doing that is morally and ethically out of our range, there can be other alternatives, such as genetically related clinics that further examine this disorder and can give useful information to people dealing with the handicap or dealing with these people in general. Another alternative stop deformities before they happen. There could be clinics set up to screne genes and mutations in couples to see if there offspring would have a chance of ending up with a deformality. Also research in DNA make-up would be one other way of scoping hadicaps and learning to deal with them.

With the proposal given human life is a presious gift to cherish, and people should have their right to live and prosper. But on the other hand, people with severe disabilities such as mental retardation and the ability to not be able to control there actions or mental aptitudes are very hard to control and be acsepted into a society of high technological being. People with gene mutation are vertually uncurable. Most of thise people end up dieng before they reach their late twenties.

People with handicaps of any kind have the right to live and do what they please in our society. These type of people I believe, give us a "drive" to never give-up. But on the other hand their ability to think in the society today is much to slow and they end up being a default in a well run machine. For the proposal to suggest these people should have everything done medically to keep them alive is uterly a waste of money.

Appendix A

Calculator Policy

POLICY: USE OF CALCULATORS ON ALBERTA EDUCATION DIPLOMA EXAMINATIONS

Background

The knowledge, skills, and attitudes relevant to technology and its uses are being incorporated into courses and programs of study wherever appropriate. Students are expected to learn the advantages and limitations of technological developments and their impact upon society. The ability to use technology helps students understand and appreciate the process of technological change, gives added depth to programs, and provides the basis for the development of skills and understanding. These expectations are reflected in the diploma examinations. Since the data provided for writing diploma examinations in mathematics and the sciences do not include information such as logarithms and trigonometric functions, students will need to use scientific calculators for these exams.

Definition

This policy considers a scientific calculator to be a hand-held device designed primarily for mathematical computations. Included in this definition are those scientific calculators having graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

Policy

To ensure compatibility with provincial *Programs of Study* and equity and fairness for all students, Alberta Education expects students to use scientific calculators, as defined above, when they are writing diploma examinations in mathematics and the sciences. Examinations are constructed to ensure that the use of particular models of calculators neither advantages nor disadvantages individual students.

Procedures

1. Teachers must, at the beginning of a course, advise students of the types of calculators that they may use when writing diploma examinations in mathematics and the sciences. Teachers must also advise students of the types of information that can be stored in calculators that are brought into diploma examinations. Calculators that have built-in notes (definitions or explanations in alpha notation) that cannot be cleared are not permitted.

2. Students must clear calculators that are brought into diploma examinations of all information they have stored except for
   a. programs used for computing values of the formulas on the diploma examination data tear-out pages or in the data booklets,
   b. programs used for graphing quadratic relations as found in the Mathematics 30/33 Interim Teacher Resource Manual.

3. Students must not bring external devices to support calculators into the exam. Such devices include manuals, printed or electronic cards, printers, memory expansion chips or cards, external keyboards, or any annotations outlining operational procedures for scientific calculators.

4. In preparation for calculator failure, students may bring extra calculators and batteries into the exam room.

5. During exams, supervising teachers must ensure that
   a. all calculators operate in silent mode,
   b. students do not share calculators or information contained within them,
   c. calculator cases are stored on the floor throughout the exam, and
   d. all examination rules are followed.

6. If you have any questions or comments about the implementation of this policy, please contact the Math/Science Unit, Student Evaluation Branch, at 403-427-0010 or FAX 403-422-4200.

Examination Rules

Appendix B

GRADE 12 DIPLOMA EXAMINATIONS

1. **Admittance to the Examination Room**
   Students must not enter or leave the examination room without the consent of the supervising teacher.

2. **Student Identification**
   Students must present identification that includes their signature and photograph. One of the following documents is acceptable: driver's licence, passport, or student identification card. Students must not write an examination under a false identity or knowingly provide false information on an application form.

3. **Identification on Examinations**
   Students must not write their names or the name of their school anywhere in or on the examination booklet, other than on the back cover.

4. **Time**
   Students must write an examination during the specified time and may not hand in a paper until at least one hour of the examination time has elapsed. Students who arrive more than one hour after an examination has started will not be allowed to write the examination. Students who arrive late but within the first hour of an examination sitting may be allowed to write only at the discretion of the supervising teacher.

5. **Discussion**
   Students must not discuss the examination with the supervising teacher unless the examination booklet is incomplete or illegible. Students must not talk, whisper, or exchange information with one another.

6. **Answer Sheets**
   Students must use an HB pencil to record their answers on the machine-scorable answer sheets.

7. **Materials Allowed:**
   - ***English 30, English 33:***
     For Part A only, all students may use a print or electronic dictionary (English language or translation), a thesaurus, and an authorized writer's handbook (for example: *The Canadian Writer's Handbook*, Prentice Hall).
   - ***Français 30:***
     For Partie A only, all students may use a print or electronic dictionary (French language or translation), a thesaurus, and a book of verb forms/tenses.
   - ***Biology 30, Mathematics 30, Physics 30:***
     Tear-out data pages are provided in the examination booklets. Students need to use scientific calculators, but must not share them.
   - ***Chemistry 30, Mathematics 33, Science 30:***
     Students must use the separate data booklet provided for each of these examinations. Students need to use scientific calculators, but must not share them.
   - ***All mathematics and science examinations:***
     Students may use calculator programs designed to perform mathematical computations and/or those designed to assist students in graphing.

8. **Materials Not Allowed:**
   - ***All Subjects:***
     Students must not bring any papers, notes of any kind, books (other than those allowed, see #7) into the examination room. Students must ensure that dictionaries (print and electronic), references, and calculators are completely free of notes or study material.
   - ***Biology 30, Chemistry 30, Mathematics 30, Mathematics 33, Physics 30, Science 30, Social Studies 30, Social Studies 33:***
     Reference materials and dictionaries (translation, English and/or French language) are not allowed.

Revised 25 August 1995

Appendix C

Guidelines for Significant Digits, Manipulation of Data, and Rounding in the Mathematics and Sciences Diploma Examinations

Significant Digits

1. For all non-logarithmic values, regardless of decimal position, any of the digits 1 to 9 is a significant digit; 0 may be significant. For example:

   123 0.123 0.00230 2.30×10^3
   all have 3 significant digits

2. Leading zeros are not significant. For example:

   0.12 and 0.012 each have two significant digits

3. Trailing zeros to the right of the decimal are significant. For example:

   0.123 00 and 20.000 each have five significant digits

4. Zeros to the right of a whole number are considered to be ambiguous. **The Student Evaluation Branch considers all trailing zeros to be significant**. For example:

   200 has three significant digits

5. For logarithmic values, such as pH, any digit to the left of the decimal is **not** significant. For example:

   a pH of 1.23 has two significant digits
   a pH of 7 has no significant digits

Manipulation of Data

1. When adding or subtracting measured quantities, the calculated answer should be rounded to the same degree of precision as that of the least precise number used in the computation **if this is the only operation**. For example:

   12.3 (least precise)
   0.12
   $\underline{12.34}$
   24.76

   The answer should be rounded to 24.8.

2. When multiplying or dividing measured quantities, the calculated answer should be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits **if this is the only operation**. For example:

   (1.23)(54.321) = 66.81483

   The answer should be rounded to 66.8.

3. When a series of calculations is performed, each interim value should not be rounded before carrying out the next calculation. The final answer should then be rounded to the same number of significant digits as are contained in the quantity in the original data with the fewest number of significant digits. For example:

   In determining the value of (1.23)(4.321)/(3.45 – 3.21), three calculations are required:

   a. 3.45 – 3.21 = 0.24

   b. (1.23)(4.321) = 5.31483

   c. 5.31483/0.24 = 22.145125

      [Not 5.31/0.24 = 22.125]

   The value should be rounded to 22.1.

   Note: In the example given, steps *a* and *b* yield interim values. These values should not be used in determining the number of significant digits.

Rounding

1. When the first digit to be dropped is less than or equal to 4, the last digit retained should not be changed. For example:

   1.2345 rounded to three digits is 1.23

2. When the first digit to be dropped is greater than or equal to 5, the last digit retained should be increased by one. For example:

   12.25 rounded to three digits is 12.3

Appendix D

Explanations of Cognitive Levels

Knowledge refers to those behaviours and test situations that emphasize the remembrance, either by recognition or recall, of ideas, material, or phenomena.

Comprehension refers to responses that demonstrate an understanding of the literal message contained in a communication.

Application requires the student to apply an appropriate abstraction (theory, principle, idea, method) to a new situation.

Analysis comprises the ability to recognize unstated assumptions, to distinguish facts from hypothesis, to distinguish a conclusion from statements that support it, to recognize facts or assumptions that are essential to a main thesis, to distinguish cause–effect relationships from other sequential relationships, and to recognize a writer's viewpoint.

Synthesis is the production of a unique communication. It is the ability to propose ways of testing hypotheses, the ability to design an experiment, the ability to formulate and modify hypotheses, and the ability to make generalizations.

Evaluation is defined as making judgements about the value of ideas, solutions, and methods. It involves the use of criteria to appraise the extent to which details are accurate, effective, economical, or satisfying. Evaluation includes the ability to apply given criteria to judgements of work done, to indicate logical fallacies in arguments, and to compare major theories and generalizations.

Directing Words

Discuss

The word "discuss" will not be used as a directing word on math and science diploma examinations because it is not used consistently to mean a single activity.

The following words are specific in meaning. The corresponding cognitive levels are enclosed in parentheses.

Contrast/Distinguish

Point out the *differences* between two things that have similar or comparable natures. (Analysis)

Compare

Examine the character or qualities of two things by providing characteristics of both that point out their mutual *similarities* and *differences*. (Analysis and/or Evaluation)

Conclude

State a logical end based on reasoning and/or evidence. (Evaluation)

Criticize

Point out the *merits* and *demerits* of an item or issue. (Analysis and Evaluation)

Define

Provide the essential qualities or meaning of a word or concept. Make distinct and clear by marking out the limits. (Knowledge)

Describe

Give a written account or represent the characteristics of something by a figure, model, or picture. (Knowledge)

Design/Plan

Construct a plan, i.e., a detailed sequence of actions, for a specific purpose. (Application and/or Synthesis)

Enumerate

Specify one by one or list in concise form and according to some order. (Knowledge)

Evaluate

Give the significance or worth of something by identifying the good and bad points or the advantages and disadvantages. (Analysis and Evaluation)

Explain

Make clear what is not immediately obvious or entirely known; give the cause of or reason for; make known in detail. (Comprehension)

How

Show in what manner or way, with what meaning. (Comprehension)

Hypothesize

Form a tentative proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect. The proposition should be testable logically and/or empirically. (Analysis and Synthesis)

Identify

Recognize and select as having the characteristics of something. (Knowledge)

Illustrate

Make clear by giving an example. The form of the example must be specified in the question; i.e., word description, sketch, or diagram. (Comprehension and/or Application)

Infer

Form a generalization from sample data; arrive at a conclusion by reasoning from evidence. (Evaluation)

Interpret

Tell the meaning of something, present information in a new form that adds meaning to the original data. (Comprehension)

Justify/Show How

Show reasons for or give facts that support a position. (Evaluation)

Outline

Give, in an organized fashion, the essential parts of something. The form of the outline must be specified in the question; i.e., lists, flow charts, concept maps. (Knowledge and/or Comprehension)

Predict

Tell in advance on the basis of empirical evidence and/or logic. (Application)

Prove

Establish the truth, validity, or genuineness of something by giving factual evidence or logical reasons. (Evaluation)

Relate

Show logical or causal connection between things. (Analysis)

Solve

Give a solution for a problem; i.e., explanation in words and/or numbers. (Analysis and Synthesis)

Summarize

Give a brief account of the main points. (Comprehension)

Trace

Give a step-by-step description of the development. (Knowledge)

Why

Show the cause, reason, or purpose. (Comprehension and/or Synthesis)

Appendix E

Preparing to Write a Science Diploma Examination—What every student should do before the examinations!

1. Prepare a course review schedule:
    - design your schedule for the two-week period (minimum) before the examination
    - – devote one study session to overview entire course
    - – devote one study session to your most difficult topic
    - divide the course material into sections and indicate on the schedule the time blocks to be devoted to each section
    - – take into account the examination blueprint available from your teacher (*Diploma Examinations Program Information Bulletin* for the course). Note that course units are not equally weighted on the diploma examination
    - – take into account units/concepts that you find most difficult; i.e., allocate more time for the review of these
    - – take into account time to write practice questions and/or examinations
2. Obtain and review examination schedules, rules, and policies:
    - record the time and place of writing
    - note minimum and maximum writing times permitted
    - prepare to remain in the examination room for at least 2.5 h (Kleenex, cough drops, etc.)
    - identify materials allowed for writing each examination, such as pencils, pens, calculators, mathematical instruments, and clear plastic ruler
3. Identify and collect examples of each type of question that will be asked:
    - obtain a copy of the relevant information contained in the *Diploma Examinations Program Information Bulletin* for the course (available from your teacher)
    - review the format of previous diploma examinations (available from your teacher)
    - learn the meanings of key “directing” words such as compare, describe, evaluate, explain, illustrate, interpret, justify, prove, and solve
4. Make summaries and point form outlines of class notes and textbook readings:
    - distinguish between major concepts and factual details
    - identify essential skills that can be assessed on paper and pencil tests
    - review lab results and procedures— identify connections between lab reports, class notes, and textbook
    - anticipate examples of connections between concepts and the “real world”
    - prepare a glossary of important subject terminology
5. Review the data booklet for Chemistry 30 or Science 30, or the data tear-out pages for Biology 30 or Physics 30 and review formulas and equations if applicable
    - link each formula or equation with a calculation done on a previous test or assignment
    - identify any restriction on the use of each formula or equation
6. Use memory aids such as:
    - colour coding, underlining, highlighting, jotting key words in margins
    - numbering points to be memorized
    - grouping word and idea associations
    - reading aloud key words, expressing key words in your own words
7. Review the different question formats and the instructions on how to answer these questions.

Appendix F

Suggestions for Students When Writing Science Diploma Examinations—What every student should know when writing examinations!

1. Do not be afraid to answer each question even if you are not sure of the correct solution to the problem. A penalty is NOT given for guessing on the machine-scored section the exam. Partial marks are often awarded for incomplete answers in the written-response section of the exam.

2. If you are stuck on a question, mark the alternatives that you know are incorrect and choose from the ones that are left using logical guessing strategy. Think of the questions as challenges and cultivate a positive attitude about your ability to answer them.

3. Scan the sets of questions of the examination before answering a particular question. The questions in one set of the examination may jog your memory about a question in another set.

4. When first reading a multiple-choice question, locate and circle key words to help clarify the meaning of the question. Then hide the alternatives and try to formulate an answer of your own. Your answer may be very close to the correct alternative.

5. If a multiple-choice question involves a calculation, do the calculation and select the alternative that is closest to your answer. A multiple-choice calculation is usually short. If you cannot do it in five minutes, your method is either inappropriate or incorrect. Go on.

6. Diagrams on examinations are often labelled with numbers or letters. It may be useful to write in the names of the labelled structures or features that you can identify.

7. When reading graphs, use a clear plastic ruler to more accurately extrapolate or interpolate data.

8. Have a good reason for changing an answer. Do not change an answer on a hunch. Do not waste your time looking for patterns of As, Bs, Cs, or Ds in multiple-choice answers. There are none.

9. You may not have time to write and edit a complete rough copy for each written-response question, but you should prepare an outline of your answer and use it as a guide when writing your good copy.

10. When completing a written-response question, keep in mind the reader of your response. The reader will want to know how well you:
    - understand the problem or the mathematical/science concept
    - can correctly use the mathematics involved
    - can use problem-solving strategies and explain your answer and procedures
    - can communicate your solutions and mathematical/science ideas

11. Rewriting a statement of the question is often a good way to begin a written response. Conclude with a summary statement. Be sure you have clearly explained all assumptions and have verified your conclusions.

12. Keep track of the time and pace yourself. Put a check mark by items that you are uncertain about and return to them if there is time at the end of the examination.

Appendix G

Science Process Words

Hypothesis: A single proposition intended as a possible explanation for an observed phenomenon; e.g., a possible cause for a specific effect.

Conclusion: A proposition that summarizes the extent to which a hypothesis and/or a theory has been supported or contradicted by the evidence.

Experiment: A set of manipulations and/or specific observations of nature that allow the testing of hypotheses and/or generalizations.

Variables: Conditions that can change in an experiment. Variables in experiments are categorized as:

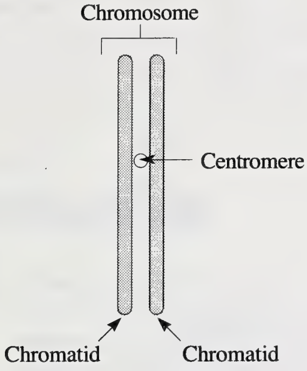
- *manipulated variables* (independent variables)—conditions that were deliberately changed by the experimenter
- *controlled variables* (fixed or restrained variables) —conditions that could have changed but did not, because of the intervention of the experimenter
- *responding variables* (dependent variables)—conditions that changed in response to the change in the manipulated variables

For additional clarification of the specialized words used to describe science process skills, see Al Gibbs, Anton E. Lawson, "The Nature of Scientific Thinking as Reflected by the Work of Biologists & by Biology Textbooks," *The American Biology Teacher*, March 1992, Volume 54, Number 3, page 137.

Technology: The development of our understanding of science is directly related to the development of technology. The meaning of technology has many facets, but in general, technology refers to a way of doing something. This includes the development of tools and new techniques for solving problems. It also includes ideas and their organization for achieving practical purposes. In the context of an examination question, technology includes both these facets of meaning. That is, a technological explanation should include not only identification and descriptions of equipment (tools, products) but also explanations of procedures.

Chromosome Number Descriptions

Haploid and Diploid



A chromosome may consist of a single strand of genetic material or, following replication, two strands of genetic material (two chromatids) joined by a centromere.

A diploid cell has two sets of chromosomes, each chromosome consisting of either a single strand or a double strand of genetic material joined by a centromere. In the process of meiosis, the first nuclear division (meiosis I) reduces the number of chromosomes from the diploid number ($2n$, two homologous chromosomes of each parental type) to the haploid number (n, one chromosome of each parental type). Each of the two daughter cells produced by meiosis I contains one set of chromosomes, albeit, each chromosome consists of two strands joined by a single centromere. During meiosis II the centromeres divide and the two chromatids of each pair separate. The four cells produced are also described as haploid. A haploid cell has one set of chromosomes, each chromosome consisting of either a single strand or a double strand of genetic material joined by a centromere.

For a particular species, haploid (n) and diploid ($2n$) conditions can be distinguished in cells that are undergoing division by counting and comparing the number of centromeres.

Genetic Conventions

Probability

The convention followed in most current genetic journals and texts is to express probability as a decimal value. Therefore, if the word "probability" is used in a numerical-response question, a note will be provided requesting that the answer be expressed as a value from 0 to 1.

Names of Diseases

Current journals and texts use the non-possessive form of the name of the discoverer of a syndrome; e.g., Down syndrome, Turner syndrome, Klinefelter syndrome.

Appendix H

Instructions for Completing the Numerical-Response Questions

One or more numerical-response questions follow a title printed in inverse type.

Numerical Response

Question numbers for numerical-response questions are printed in inverse type.

1.

Each question has a place for the student to record an answer before recording it on the answer sheet.

Answer: ______ (Record your answer to three significant digits in the numerical-response section of the answer sheet.)

Numerical-Response Questions with Answers that are Determined by Calculation

Students are expected to follow the guidelines for significant digits, manipulation of data, and rounding provided in Appendix C. Students will be directed to provide a specific number of significant digits. The number of digits requested does not include the decimal point or a leading zero. A leading zero, although not significant, must be recorded if the answer is a value between 0 and 1. Units or negative signs are never recorded.

Example:

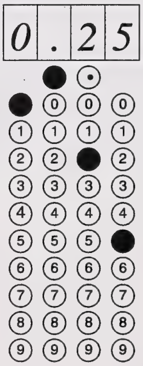
Numerical Response

2. In peas, tall is dominant over short. If two heterozygous tall pea plants are crossed, what is the probability that short offspring will be produced?

Answer: 0.25 (Record your answer to two significant digits in the numerical-response section of the answer sheet.)

Notice that in the answer to this question, the leading zero is recorded.

The word "probability" in the stem of this question indicates that a value from 0 to 1 inclusively is required. If a percent is required, this will be indicated in the stem.



Numerical-Response Questions with Answers Derived by Determining a Sequence of Events or Structures

Some numerical-response questions will direct students to select events or structures from a list and determine the correct sequence in which the events occur or the structures are used. Students should select and determine the correct sequence of only those events or structures that meet the criteria provided in the stem. Depending on the question, the correct answer may contain two, three, or four digits. The answer is recorded in the correct sequence.

Example:

Numerical Response

3. From the list of parts at the right, provide the correct sequence in which light passes through a microscope to reach the eye of an observer.

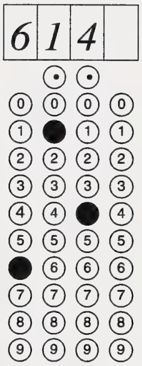
Some Parts of a Microscope

1 Objective
2 Arm
3 Coarse adjustment knob
4 Eyepiece
5 Fine adjustment knob
6 Diaphragm

Answer: 6 1 4 (Record your answer in the numerical-response section of the answer sheet.)

Notice that the answer to this question is recorded beginning in the left box. Unused boxes are left blank.

In this question, students are not told how many parts to select. They must determine how many selections are appropriate and record them in the correct sequence.



DATE DUE SLIP

DUE EDUC FEB 04 '96

F255

0

University of Alberta Library
0 1620 0399 0601

Biology 30 Information Bulletin